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## PROBLEMS OF SUBSTITUTION FOR NONFERROUS METALS AND ALLOY STEELS

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/Comment: The State Committee of the Council of Ministers USSR on Supplying the National Economy with Engineering Materials initiated a new monthly publication Za Ekonomiyu Materialov (For the Conservation of Materials), which is designated for wide dissemination of advanced experience in the field suggested by its title. This report represents information from an article in issue No 1, published August 1952./

The Soviet government pays considerable attention to regulating the consumption of valuable materials and to replacing these materials with less scarce and less expensive substitutes. Results of this activity are very noticeable. Fields of application for the most important nonferrous metals and alloys, and for some grades of alloy steels, were revised, eliminating to a considerable extent excessive consumption of these materials. A number of new alloys and steel substitutes were developed and are now used in production.

Thus, the tinning process was replaced without impairing the quality of products by coating with solders, lead, or zinc. Application of high-tin babbitt was reduced. A number of productions use a substitute for lead. Measures have been taken for replacing molybdenum with other elements in a number of tool steels.

Side by side with certain progress, however, some branches of industry are lagging in the solution of numerous problems connected with the use of substitutes, and still use nonferrous metals and high-alloy steels in numerous cases where there is no necessity for their consumption.



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For example, the Ministry of Ferrous Metallurgy consumes a large quantity of lead for wire patenting, whereas good results from patenting wire in salts have been obtained at a number of plants, especially at the "Krasnaya Etna" plant of the Ministry of the Automobile and Tractor Industry.

The Ministry of Transport Machine Building for a long time has been conducting experiments on substitutes for molybdenum steels in the production of tractors and other machines, but has obtained no definite results as yet.

The Ministry of the Automobile and Tractor Industry and the Ministry of the Chemical Industry delayed research and tests in the field of nonmetallic materials for leveling the welded joints on automobile bodies; lead-tin solders are now used for this purpose. The Academy of Sciences does not contribute sufficiently to this work.

These and similar facts show that work on the development and application of substitutes is not yet in a proper place in the activity of ministries and scientific-research institutes. Such work is frequently conducted by industrial enterprises without proper technical supervision and without any control by corresponding ministries.

The present use of substitutes for nonferrous metals and alloy steels is far from exhaustive. Further work must be carried out to develop and apply new substitutes as well as to expand the use of the materials already developed and tested in production.

Substitutes for tin bronzes, babbitt, and lead are of great significance for the national economy. These metals may be replaced with antifriction cast irons, wood plastics, graphitized steel, tinless bronzes, chemically stable nonmetallic materials, etc.

Antifriction cast irons of Ts-1 and Ts-2 grades, cupola-made titanium-copper cast iron of grade B, and antifriction malleable iron show high physicomechanical and good antifriction properties. Bearings made of these cast irons showed good results under various loads and at different operating speeds in a variety of machines and mechanisms.

Despite all this, the utilization of antifriction cast irons is still inadequate. Individual ministries use from tens of tons to several hundreds of tons per year. This inadequate use is caused mainly by a lack of proper organization and planning in the production and distribution of metals.

Certain branches of the machine-building industry have arranged production of antifriction cast irons only for their own needs. In such cases, ministries not involved in the machine-building activity can not obtain them at all. In order to reduce the consumption of bronze, the manufacture and utilization of antifriction cast irons must be sharply increased.

Substantial development must be expected soon in the manufacture of laminated wood plastics, which are plates consisting of thin sheets of rotary-cut birch wood impregnated with resol resins and glued together. These plastics are designated for making bearing liners and for use as constructional and insulating material instead of babbitt, bronze, and other materials.

Wood plastics possess fairly high physicomechanical and antifrictional properties and have found application in numerous industrial branches. Thus, the metallurgical industry uses wood-plastic bearings in rolling, drawing, and broaching mills; roller beds; crushers; conveyers; and other machines. In the Ministry of Electric Power Stations, wood-plastic bearings are used in hydraulic turbines, water pumps, traveling wheels of flat gates, and other mechanisms.



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The utilization of wood-plastic materials in place of bronze and babbitt could be much broader, but machine-building and other ministries do not pay proper attention to this matter. In some ministries the estimated requirements for wood plastics in 1952 are lower than the actual consumption of these materials in 1951. Meanwhile, the productive capacity of the Ministry of the Paper and Wood-Processing Industry in the field of wood plastics is considerably higher than requirements.

Another wood product which may be used as material for bearing liners is plasticized wood made by pressing out finely cut wood crumbs impregnated with synthetic resol resins. This material has the advantage of eliminating waste in the process of pressing, whereas at least half of the material is wasted in manufacturing articles from laminated wood plastics. In spite of this, the production of parts from plasticized wood is not yet well established.

Wider application of zinc alloys and aluminum bronzes instead of high-tin bronzes and, to some extent, babbitt, would conserve tin, copper, and lead considerably.

The zinc alloy of the TsAM10-5 type is fully established as an antifriction material in bearings at a work intensity up to 100 kg-m/sq cm sec, permitting a mean bearing pressure up to 200 kg/sq cm and a rubbing velocity under small loads of over 5 m/sec.

Aluminum bronzes of BrZh9-4 and BrAZhN10-3-1.5 grades are good substitues for high-tin antifriction bronzes in manufacturing the heavy-duty parts of numerous machines.

Aluminum bronzes, despite their very high qualities, do not yet occupy a proper place in machine building, owing mainly to inadequate supply of them by the nonferrous metallurgical industry. Their manufacture at machine-building plants is difficult because of certain particular conditions to be observed in the process of melting and pouring.

Graphitic steels, in regard to their antifrictional properties, surpass antifriction cast irons and serve in numerous cases as a sound substitute for bronzes. Bearings and sleeves made of these steels may work under high bearing pressures up to 300 kg/sq cm and at rubbing velocities up to 3 m/sec.

According to data of the Ukrainian Institute of Metals, bearing liners made of graphitic steel, when used in rolling mills under high mean pressures from 200 to 400 kg/sq cm and at velocities from 1.1 to 1.5 m/sec, show a greater durability than that of similar liners made of tin bronze.

Graphitic steels represent one of the best materials for cold drawing dies for sheet metal, and for trimming and punching dies. A stamping die made of graphitic steel upon testing at ZIS (Automobile Plant imeni Stalin) showed considerably higher endurance than similar dies made of carbon U10A steel and high-chromium-molybdenum steel of Kh12M grade.

Despite the valuable properties of graphitic steels, they are used insufficiently in the Soviet machine-building industry.

In addition to the basic substitutes for lead-tin babbitts and tin antifriction bronzes mentioned above, there is a long list of other ferrous alloys which provide, to a certain extent, for the conservation of tin, lead, and copper. These alloys include secondary tin bronzes, manganese bronzes, copper-zinc alloys, silicon, and other brasses.

An important place in the national economy must be assigned to new nonferrous alloys, such as babbitt of B-2 grade, for bearings with a thin lining.



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A measure for saving lead and tin in automobile and tractor building is the use of three-layer liners made by casting or pressing a lead-bronze layer on a steel backing and subsequently coating the bronze surface with babbitt or tin to a thickness of 0.1 - 0.025 mm.

Another still more effective measure for conservation of nonferrous alloys in production of automobile and tractor engines is suggested by using thin-walled bimetal bearing liners made of a bonded steel-aluminum alloy strip.

Measures for the conservation of lead, used in the chemical and other industries as a chemically stable material, are of great significance. These measures, first of all, include the development of production and application of such industrially well-established nonmetallic materials as faolite, "viniplast" and "asbovinil." These materials are highly stable in various acids and may be used not only for lining the walls of chemical equipment but also in the fabrication of pipes, fittings, valves, pumps, cocks, etc.

Further expansion in the use of cables without a lead covering, and conservation of lead in paint manufacture, demand an increase in production of polyvinylchloride masticated rubber and vinyl-perchloride enamels and lacquers.

Polyisobutylene and polyethylene are effective substitutes for lead, when it is used in active media. Polyisobutylene shows good chemical stability against the majority of acids and alkalies at temperatures up to 100° C, does not age, and is capable of fusing in a stream of hot air. Polyethylene possesses high dielectric and good physicomechanical properties, and high resistance to the action of acids and alkalies. In addition, it is resistant to aging and withstands temperatures up to 50°.

Graphitic materials and pyrophyllite should be widely used as substitutes for lead. The graphitic materials have high thermal conductivity and chemical stability.

A new graphitic material, known under the name "antegmit," has been developed recently in the Soviet Union. It is prepared by pressing graphite powder with phenol-formaldehyde resin. This process is considerably simpler than obtaining graphitic materials by impregnating graphite with resins.

Antegmit shows good heat conductivity and great mechanical strength. Impregnated graphite has a somewhat higher heat conductivity and is thermally stable at temperatures up to 350° C. Both materials may find wide application as lead substitutes in heat-exchange equipment, in the production of sulfuric and hydrochloric acids, in the fabrication of pipes, fittings, and pumps, and for lining various chemical equipment.

Increased production of graphitic materials is extremely important for the release of a large amount of lead, which has heretofore been essential in heat-exchange equipment for the chemical and cellulose-paper industries, and in nonferrous metallurgy.

Another new material, pyrophyllite, is a mineral with abundant deposits in the USSR. Pyrophyllite products are absolutely acidproof and their compression strength is 5,000 kg/sq cm, i.e., 20 times the strength of ordinary acid-resistant ceramic products. In addition, they are gasproof, stable against alkalies, and only slightly hygroscopic; they show high wear resistance and withstand sharp changes in temperature. Pipes made of pyrophyllite will withstand a pressure of over 15 atm.



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Pyrophyllite products, such as acidproof bricks, lining plates, pipes and pipe connections, and cocks, will find wide application as substitutes for lead and other nonferrous metals, alloy steels, and porcelain products in various industrial branches.

Taking into consideration the high operating properties of pyrophyllite products, the simplicity of their fabrication, and the unlimited source of raw materials, exploitation of pyrophyllite deposits must be developed on a large scale.

Conservation in the use of alloy steels and alloying elements is a task of great economic significance. This article touches only certain aspects of the problem.

Considerable conservation of steels alloyed with molybdenum and nickel may be achieved by replacing them in the fabrication of gears, piston pins, and other parts, especially in automobile and tractor production.

Case hardening of gear teeth, using high-frequency induction heating, permits the replacement of certain expensive steels with carbon, manganese, or as a last resort, chromium steels, which have in all cases an increased concentration of carbon, from 0.45 to 0.55%.

A great opportunity to conserve lies in the production, development, and utilization of clad steel. Chrome-nickel and chrome-nickel-molybdenum stainless steels, used in chemical machine building and in the production of equipment for the food and the meat and milk industries, are expensive and manufactured on a limited basis. The Kuznetsk Metallurgical Combine developed a method for cladding carbon or low-alloy steel with a thin layer of stainless steel. The new technique saves from 750 to 835 kg of stainless steel per ton of final product. The production of clad steel must be increased by all means.

In a number of construction steels, molybdenum and nickel may be replaced by titanium, vanadium, and boron. The latter is of particular interest, since its addition to a steel in the amount of a few thousandths of one percent is equivalent to a 2-3 percent summary addition of nickel, chromium, and molybdenum.

Niobium is of great interest as an alloying element in the production of heat-resistant steels and alloys. Niobium ores available in the USSR contain also tantalum, rare-earth elements of the zirconium group, and titanium dioxide. Complex processing of these ores to obtain niobium and the other elements would contribute to an expansion of the resources of alloying elements.

Titanium must be used not only as an alloying element in steels but also as a construction material, since titanium alloys with chromium, aluminum, and other metals have the ultimate strength of alloy steels (100-140 kg/sq mm) and are considerably lighter than steel.

The utilization of titanium and its alloys as construction materials requires the production of spongy or powder titanium. The technique of this production has been developed and tested under laboratory conditions. Upon the development of proper productive capacities on the raw material base existing in the Soviet Union, titanium will be available for wide application in special machine building and in acid-resistant chemical equipment. This will provide not only for reducing the weight of machines but also for releasing a considerable quantity of molybdenum and nickel.



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